(19.16) Deuterium is to be injected into a fusion reactor at a density of 10^{20} D^+ and 10^{20} e^- m^{-3} and an energy of 100 keV. How much of the deuterium must fuse to compensate for the ionization and injection energy? The ionization energy of the deuterium atom is 13 eV.

Base calculation on 1 m^3:

$eV := 1.6021773 \cdot 10^{-19} \cdot joule$ $E_{ionization} := 13 \cdot eV$ $E_{injection} := 100 \cdot 10^3 \cdot eV$

$N_D := 10^{20}$ (atoms/m^3)

$E_{used} := N_D \cdot \left(E_{ionization} + 2 \cdot E_{injection}\right)$ (We must accellerate both D^+ and e^-)

$Q_{DD} := 23.85 \cdot 10^6 \cdot eV$ $N_{fused} := \frac{E_{used}}{Q_{DD}} \cdot 2$

$x_{used} := \frac{N_{fused}}{N_D}$ $x_{used} = 0.017$ or

$x_{used} = 1.677 \cdot \%$